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ORIGINAL MEMOIRS.

ACTINOMYCOSIS.¹

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THE purpose of this paper and demonstration is to present the clinical side of the disease, actinomycosis, as it occurs in man, and as illustrated by six cases which I have recently had under observation.

I desire at the outset to disclaim any pretensions to an exhaustive knowledge of this subject from a pathological and biological stand-point, and present this work as illustrative of the working knowledge, or at least part of the working knowledge, which the surgeon should possess to enable him to successfully recognize and treat these cases occurring in his actual practice.

HISTORICAL.

Langenbeck first noted the sulphur grain-like bodies of actinomycosis in an abscess, in 1845; he did not recognize their true nature.

Bollinger, in 1877, recognized the vegetable organism of ray fungus as the cause of lumpy jaw in cattle.

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Israel, in 1878, recognized the ray fungus as the cause of disease in man.

Belfield first recognized the ray fungus in this country in lumpy jaw in cattle, and Murphy reported the first case of actinomycosis in man in this country.

The ray fungus is difficult to classify, and its classification has been a matter of much dispute. Hektoen believes that it belongs either to the simple moulds or constitutes a distinct group between moulds and bacteria.

The ray fungi are common in nature, being found in air, water, and soil, and especially as a rust on various grains and grasses. A great many varieties have been isolated, some simply saprophytic and harmless, others pathogenic. Of the pathogenic forms, two interest the clinician,—the actinomycosis generally recognized as such, and the altered form, which produces Madura foot.

The ray fungus develops from a small, round spore into cylindrical threads, which branch and form a net-work. Each single thread, with its branches, represents one whole single organism. The mass of considerable size which presents the picture of a central mass with radiating clubs is a colony of the organisms, or a group of colonies.

The ray fungus gains access to the body either through the mouth or pharynx mucosa, the respiratory tract, the alimentary tract, or the skin. Probably a lesion of the protecting epithelium must exist through which the fungus can enter, or the fungus is carried into the tissues by some foreign body, as a bit of straw or grass, or splinter of wood, or, as in one case of Madura foot, by a prong of a pitch-fork. The fungus produces granulomatous swellings in the tissues, accompanied sooner or later by suppuration and usually with mixed infection. The fungus is found in the pus, either as the ray fungus colonies or granules, which can be seen with the naked eye, or as the thread-like bodies of the single organisms to be seen on staining. In the granulation tissue the same forms can be found, but more sparingly.

The diagnosis of the lesion must be made absolute by the

finding under the microscope of the typical pictures of ray fungus colonies or threads, either in the pus or the granulation tissue. It is sometimes very difficult to do this, and a fairly satisfactory clinical diagnosis can be made from the history of the process, more or less chronic, the granulation tissue, the suppuration, and the presence in the pus and tissues of the so-called sulphur grain bodies, or, as I think they should better be described, as very minute fish-egg-like bodies—gray or translucent in appearance. In my cases I have found the actinomycotic granules gray or translucent much oftener than sulphur or yellow in color.

In this connection I want to call attention to one source of error which we have recently met with. Last week a case of an extensive ulcerative and suppurative lesion of the jaw and cheek was presented in my clinic for diagnosis. It was very suggestive of actinomycosis. I at once carefully examined the pus macroscopically, and found many bodies identical in size and shape and consistency with the granules found in actinomycotic pus. This seemed to make the diagnosis almost certain. However, an examination of a piece of tissue showed that it was an epithelioma with pus infection, and that these suspicious bodies were epithelial pearls which, with the breaking down of the infected neoplasm, were freed and floated away in the pus. Another source of error is the finding of vegetable organisms in the saliva or pus about a mouth lesion, or in faecal matter in an abdominal lesion, suggestive of actinomycosis, but in reality a mere accidental finding, with no relation to the disease.

The pus of actinomycosis has a distinctive odor, which certainly can sometimes be detected by an acute olfactory sense. It is said to be an earthy smell, similar to that found coming from freshly turned-over soil. Two of my force at the Presbyterian Hospital have distinctly recognized this odor in two cases, and suggested a diagnosis from it. In another case, where an abscess from an appendix or caecal actinomycosis broke into the vagina, the mother of the patient recognized and described this peculiar odor.

In clinical work the crushing of one of the granules with a cover-glass and inspection with a four eyepiece, and first with a three, and then a seven objective, without any staining often gives a satisfactory picture and a definite diagnosis, from the finding of the ray arrangement with clubs or fragments with threads and coccus-like bodies.

We have learned, however, not to expect to find the beautiful and clear radiating clubs pictured, especially from cases of bovine actinomycosis. Instead of this, the picture is rather blurred; often the organisms have undergone some degenerative process, which leaves nothing distinctive, and it may be necessary to search for a very considerable period before a sufficiently characteristic body is formed. I am rather led to believe that the fact just cited, *i.e.*, the difficulty of finding a clear, distinct picture of the fungus under the microscope, has frequently been the cause of error in diagnosis, and responsible for failures to recognize the lesion, when, in fact, it was present and typical. As an instance, I will say that an exceptionally well qualified diagnostician was given some pus from one of our cases, a case of lung actinomycosis. There were present many of the granules. After working over it for two hours, he reported that it was not actinomycosis, as far as he could determine, although both before and after the examination we found typical ray fungi in the pus from the same source. With the clinical picture typical, the diagnosis can be made from the thread-like forms. Cultures can be made on glycerin-agar at body temperature. The stain which Baracz recommends is gentian violet (Gram). In the tissues hæmatoxylin and eosin answer very well. Care should be taken in handling this material in the laboratory, so as to avoid possible infection of the laboratory worker; although I can find no recorded instance of such a case, yet I have had a personal communication of such a case occurring in a neighboring city.

In this same connection might be mentioned the fact that there is no positive evidence of infection of the human being from eating the meat of infected cattle, or consuming the milk or milk products from infected cattle.

One must not conclude, however, that this does not occur, and until we have much fuller knowledge than we possess at present the greatest possible precautions against such a contingency should be insisted upon, especially in view of the apparent great frequency of the disease in this locality at the present time. Indeed, the great number of lumpy-jawed cattle slaughtered in Chicago, and the apparently large (though not generally recognized) number of human victims from the same disease, suggest so strongly a possible connection that even in the absence of positive proof the greatest care should be exercised by the authorities to eliminate such a source of contamination.

We can well afford to take such a position in regard to lumpy jaw, in view of the fact that such a great authority as Robert Koch will not accept as a demonstrated fact the infection of a human being by bovine tuberculosis, not even in a single instance, and yet the opinion of most clinicians is overwhelmingly in favor of the probability of such a source of infection in a large percentage of our cases.

Clinically, actinomycosis appears under four different forms, from four different routes of infection:

1. Head and neck actinomycosis, with infection from mouth and pharynx.
2. Chest actinomycosis through the respiratory tract.
3. Abdominal actinomycosis, with infection probably always through the alimentary canal, possibly through the genital tract of the female.
4. Actinomycosis of the skin.

The ray fungus can without much doubt gain access to the tissues through a mucosa and leave at the point of entrance little or no discernible lesion. The reported cases of primary actinomycotic lesion of the brain, liver, spleen, etc., are probably explained in this way, that the fungus passed through the mucosa of the pharynx or middle ear in the brain cases, and through the intestinal mucosa in the abdominal cases, and developed in brain, liver or spleen distinct lesions, without any distinct lesion at point of entrance.

The lesions formed are primarily granulation tumors, or at least granulation tissue; thus, from a primary focus it extends in all directions, irrespective of tissues, by continuity. The lymphatic glands are seldom involved, that is, the fungus does not produce a lymphatic invasion; at least this is rare. We have, however, had one case of glandular involvement, and present a specimen from the inguinal glands of a fatal case of rectal actinomycosis.

Beside regional involvement, a pyæmic form is found, due to the breaking into a vein of a focus of the disease, the spores thus gaining access to the general circulation or portal circulation, and producing the picture of an actinomycotic pyæmia, with multiple foci in the lungs, liver, spleen, etc.

The frequency of occurrence of the disease in the various regions is found to be, roughly speaking, about 50 per cent. of head and neck actinomycosis, from 15 to 20 per cent. of chest cases, from 20 to 25 per cent. of abdominal cases, about 2 per cent. of skin cases, and a small balance where it is difficult to determine the route of infection.

I am satisfied that the disease is quite common, and is often not recognized. I have seen six cases recently, in little over a year; most of them were not recognized by the attending medical men, and in several instances the attendants were surgical experts. Personally, I feel that I recognized the first case of this growth rather by accident, and recognized the others because my attention had been called especially to the subject. The moral is that the attention of the profession must be called to the subject repeatedly, so that they will be always on the lookout for the disease. Certainly this is important from at least two stand-points:

1. If the disease is recognized, much can often be done by proper treatment.

2. If the disease is in fact as common as I am led to believe, a demonstration of this fact will probably lead to its more careful study, and possibly, I shall say probably, the development of a scheme of prophylaxis which will reduce the dangers from this source.

The prognosis of ray fungus disease is an interesting topic. Formerly, it was regarded as exceedingly bad. It is now known that many cases recover spontaneously, as do ordinary abscesses, either from pus infection or from tuberculosis. Where the lesion is so situated that the entire focus can be safely subjected to surgical treatment, as in head and neck and skin cases, the prognosis is excellent. Where this cannot be done, as in lung and extensive abdominal actinomycosis, the prognosis is exceedingly grave, but not hopeless. The treatment which was at first recommended, *i.e.*, wide extirpation of the involved tissue, as in carcinoma, is no longer regarded as necessary. The laying open of the focus or foci, the scraping away of the granulation tissue with a sharp spoon, the touching of the surface with nitrate of silver stick, the packing with iodoform gauze, the use of iodide of potash internally in good-sized but not necessarily massive doses, and eventually, if necessary, the use of the X-ray, offer a plan of treatment which will succeed if the lesion is thoroughly accessible. In lung cases we must be satisfied with curetting the accessible portions of the lesion in cases where the process has extended to the chest wall, and using iodide of potash and the X-ray. Here the prognosis is bad, a small percentage, probably less than 10 per cent., being saved.

In abdominal cases, where the lesion is limited and can be safely excised, as where it is limited to the appendix, excision, which offers an excellent prognosis, is in order. Some of the cases of actinomycosis of the appendix and intestine simulating appendix abscess recover with drainage of the abscess, without further treatment. Usually the case is not as fortunate, and second and third and multiple operations for opening abscesses and curetting sinuses will be necessary. Solutions, as recommended by Baracz, of 20 per cent. of nitrate of silver, should be carried into all the fistulæ and pockets, and the iodine treatment and X-ray employed. The prognosis in abdominal cases, roughly speaking, is 70 per cent. fatal and 30 per cent. recoveries. The skin cases give an entirely favorable prognosis when recognized and properly treated.

The pyæmic cases are hopeless. The prognosis is undoubtedly influenced more by the resisting powers of the individual than by any other factor; certainly more by this than by any scheme of treatment. This is well shown by the cases which go on to spontaneous cure after the evacuation of an abscess without any further treatment.

Treatment, however, is of absolute and demonstrated value; and it is, I repeat, of great importance that the correct diagnosis be made, so that the patient may be given the benefit of such appropriate and valuable treatment.

Of first importance is the opening of the focus and drainage, as in any abscess. Second, removal by a sharp spoon of the granulation tissue produced by the lesion. Third, the destruction of the fungi allowed to remain in the tissues by nitrate of silver in stick or solution, or by iodine. Fourth, maintenance of drainage by iodoform packing. Fifth, the use of iodide of potash either internally or as 1 per cent. injection into the tissue surrounding the focus, or by cataphoresis. Senn has employed it in both blastomycosis and actinomycosis. The veterinary surgeons employ iodide of potash in interrupted doses. The same plan may be used with the patient. Use the drug for a week, interrupting for three to five days. It is thought that better results are thus obtained on the theory that the spores are more resistant than the adult thread forms, and that the days in which the drug is not used the spores find an opportunity to develop into the adult forms, which are more easily destroyed by the action of the drug.

The X-ray seems to be of distinct value in the treatment of actinomycosis. In the treatment of blastomycosis, the combined treatment of the X-ray and iodide of potassium has proven to be of the greatest value. This clinical fact led me to do some experiments, in which I was assisted by Professor Walter S. Haines and Dr. Joseph F. Smith. The most important result which we obtained was this, that the X-ray liberated free iodine in solutions of iodide of potash, and we believed that it was fair to conclude that given a patient with a lesion of blastomycosis or actinomycosis, saturated with

iodide of potassium and exposing the lesion to the X-ray, free nascent iodine is liberated in greater amounts than without such exposure, at and about the seat of the lesion, and that the apparent striking clinical results from such combined treatment, which I call radio-chemic treatment, found at least a possible explanation.

It would seem as though our knowledge of actinomycosis is at present limited. From the very considerable progress which we have made in the last few years in the way of bettering the prognosis by improved methods of treatment, we are justified in hoping that a further study of the disease may result in the discovery of knowledge which will enable us to more easily recognize the condition, and which will furnish us the means of prophylactic treatment and curative treatment, which will eradicate the trouble.

CASE I.—H. E., aged eleven years; school-boy. Family history negative. Previous history: Pneumonia when a year and a half old. Measles at two years. Present trouble: Four days previous to admission to hospital the patient received a blow in the abdomen. The same evening, after eating a hearty meal, he complained of pain in right abdomen and in epigastrium. Pain increased the following day, reaching its maximum the second day. There was some nausea and diarrhoea. The next two days the pain gradually diminished in severity. Patient had not previously suffered from similar attack.

June 15, 1904. Admitted to the hospital, complaining of only slight abdominal distress. Examination showed patient to be a fairly well nourished boy. Abdomen was symmetrically distended and tympanitic, except for dull area in right lower quadrant. An indefinite mass could be made out in this region, which was not very tender. No bulging felt per rectum. Blood count showed 62 per cent. hæmoglobin, and leucocytes 23,500. Urine showed hyaline and granular casts. Temperature, 101° F.; pulse, 112; respirations, 30.

June 16. Muscle-splitting incision made over swelling and pus evacuated and drainage inserted.

June 17. Temperature was 101° F., and on subsequent days

gradually receded to 99° on June 21. Temperature then began a gradual ascent, and remained between 101° and 102.5° F.

White counts were as follows: June 27, 22,250; June 28, 22,800; June 29, 23,700; July 1, 23,950.

About June 28 a swelling was noticed in right hypochondriac region. This was firm and slightly tender to touch. It increased in size in next few days.

July 1. Incision was made into this mass, and thick pus evacuated, in which were noticed distinct yellow granules. Under the microscope these proved to be colonies of the ray fungus. Drainage was instituted. Temperature remained about 100° F. for next few days, and July 7 went to 103° F.

July 8. Stomach contents were noticed on dressings from upper wound. Nutrient enemata then commenced, with nothing by mouth.

July 8. Leucocytes, 20,800.

July 11. Gradual return to mouth feeding begun. X-ray treatment every second day.

July 16. Potassium iodide commenced, gr. v, t. i. d., increasing dose by one grain daily till twenty grains were reached.

July 18. Leucocytes, 13,250. Patient then went on to complete recovery, and was discharged from hospital August 10. Continued potassium iodide, grs. x, t. i. d., at home.

January 1, 1905. Patient in good condition. No evidence of actinomycosis. In December had an attack of pain and vomiting, which lasted a few hours. Patient again placed on potassium iodide.

CASE II.—V. V., aged forty years; Swiss; occupation, car repairing. Residence, Hammond, Ind. Family history negative. Previous history: Malaria twenty years ago. No venereal infection. Present trouble began three years ago, with severe pain in right lower chest. It kept him from work for about three weeks. He then considered himself well, and continued to work till two years ago, when he had a return of the trouble, and a "sore spot" was noticed near the sixth rib in the mammillary line on right side. The tenderness would nearly disappear at times, and he would be able to work. About one year ago a lump appeared on chest-wall at seat of the tenderness. This gradually increased in size until seven weeks ago, when it was opened and pus escaped. Since then there has been a continual discharge of pus.

Patient admitted to hospital August 31, 1904. Physical examination at that time showed a reddened area and discharging sinus at fifth interspace in mammillary line on right side. Dulness was present, and breath and voice sounds absent below sixth rib, behind on right, and below fifth rib anteriorly. Examination otherwise negative. Pulse, 100; temperature, 98.8° F.; respirations, 24.

September 1. Resection of sixth rib in axillary line on right side. A very thick pleura was cut through and adherent lung freed by finger. About one and one-half ounces of pus escaped. Sinus curetted. Temperature following operation was 100° F., and subsequently fluctuated for several days, the highest recorded being 101° F. Respirations did not go above 28. Temperature then gradually came down to normal, and has remained so except for occasional rise to 99° F. and 99.2° F.

September 10. Sputum was brownish-yellow and contained mustard-seed-like granules, which, under the microscope, proved to have the typical ray fungus appearance.

September 12. Bodies were again found in the sputum and clubbed rays demonstrated under the microscope.

September 13. Began potassium iodide, ten grains three times daily, increasing dose by two grains daily. Discontinued September 18, on account of stomach disturbance.

September 24. Potassium iodide again, taking grs. v, t. i. d. Discharged from hospital, September 26, 1904. Weight is increasing about two pounds a week under the iodide. Expectoration is diminishing; still find ray fungi. Temperature now normal, except for occasional slight evening rise. Strength improved so that he has returned to work. Prognosis is, of course, very grave, as in all cases of lung actinomycosis, and yet the marked improvement in this case is encouraging.

CASE III.—E. J. G., aged thirty-one years; Augusta, Ill.; farmer. Family history negative. Previous history: Pneumonia eight years ago. Denies any venereal infection.

Present trouble began two months ago, when patient first noticed a "kernel" in left side of neck, about one inch below inferior maxilla and one and one-half inches from median line. When first noticed, it was about the size of a hazel-nut, and not painful to pressure. This gradually increased in size, and for the past month has been the seat of more or less pain. Patient has

"felt hot in face" at times, but temperature has never been taken. Has no cough. Expectorates rather frequently, and occasionally sputum is blood-streaked. Patient admits habit of chewing grain and spears of grass. Admitted to hospital December 6, 1902.

Examination.—General appearance excellent. Weight, 197 pounds. Upon left side of neck, beneath the maxilla, is a marked swelling extending from below the left ear almost to the middle line. It is hard and almost "wood-like" in density. Only slight tenderness. Overlying skin a deep red and fixed over the mass. In centre of the mass is made out a small fluctuating area. Later this was incised and a small quantity of pus escaped. Repeated examinations of this pus showed threads. No granules or radiating threads found.

Treatment.—No further operation. Hot dressings daily. X-ray treatment every second day. Potassium iodide, beginning December 12, 1902, with grs. xv, t. i. d., increasing dose one grain daily till January 2, after which grs. 1, t. i. d.

Temperature on entrance was 100° F.; pulse, 112; respirations, 24. Following incision, temperature, pulse, and respirations came down to normal. After December 23, 1902, became somewhat accelerated, and subsequently varied between 96 and 120. With light attack of tonsillitis, January 13, 1903, there was a rise of temperature to 103° F.

The area of induration gradually diminished in size and became softer, and at time of discharge from hospital, January 21, 1903, there was no longer any pus, and area had diminished to one-quarter the size at entrance.

One year later no trace of lesion remained.

CASE IV.—F. R., aged fifty years; Spirit Lake, Iowa; farmer. Family history negative. Previous history negative. Denies venereal infection.

Present trouble: In June, 1903, patient had trouble in the rectum, which he supposed was due to piles, and in August underwent an operation. At this time the doctors told him that there were ulcers in the rectum. September, 1903, an abscess formed in front of anus, and was operated upon. There was some difficulty with urination. He passed pus from rectum from time of first operation, at one time quite a large amount. Sinus remaining after opening of abscess continued to discharge until time of entrance to hospital, November 3, 1903. Examination on entrance

showed body much emaciated. Perineum red and swollen. Two fistulæ in front of anus leading up towards the rectum. No. 20 sound passed in urethra. Urine negative. Temperature, 101° F.; pulse, 112; respirations, 28.

November 4. Operation. Sinuses incised upward towards rectum. Granulation tissue curetted. Wounds packed with iodoform gauze.

Discharged from hospital December 22, 1903.

Admitted to my service, May, 1904, with two fistulæ about rectum. General health bad; weak and emaciated. Diagnosis at this time tuberculosis. Fistulæ curetted and packed. No improvement followed the operation. Within a few weeks an inguinal bubo developed on the right side. This was opened, and in the pus the granules of ray fungus were seen. These were examined under the microscope, and the diagnosis confirmed. The patient was placed on iodide of potash and the X-ray. No improvement followed. The disease had evidently gained uncontrollable headway, and invaded first one hip-joint and then the other; then the sacrum and spinal column and spinal cord. Death from pneumonia.

CASE V.—Young girl living in a suburb, with parents. Miss A. B., seen with Dr. Knight, of Waukegan, Ill. Nineteen years of age. Family history negative. Personal history negative, except for the following: In August, 1904, had an attack of abdominal pain; was confined to bed for several weeks. Diagnosis uncertain at first; later an abscess discharged through the vagina; about a pint of pus escaped. The mother of the patient stated that the pus was not ordinary yellow matter, but gray in appearance, and of the peculiar odor of decaying matter. The patient recovered from this attack, but never fully regained her health. About three days before I saw the case, in November, 1904, the patient was taken with an attack of pain in the abdomen and sharp fever, as high as 104° F. The probable diagnosis of appendicitis was made, and I was called upon to operate. Bimanual examination through rectum and abdominal wall showed a mass in the cul-de-sac of Douglas. Under ether this was opened through the vagina and drained. A peculiar bloody pus, with suspicious bodies, escaped. An examination of these bodies showed ray fungi. We had here probably an actinomycosis

of the appendix or cæcum, with perforation, to deal with. The young girl has improved greatly, and is now under iodide treatment.

CASE VI.—J. H.; captain of lake vessel; thirty-five years of age. Family history negative. Previous history negative.

Present trouble began more than two years ago, with an abscess in the region of the appendix. This was opened and drained. Patient never entirely recovered his health and strength. Complained of intestinal symptoms, and later an exploratory operation was made and the peritoneal cavity was found obliterated by adhesions, and the diagnosis of tuberculosis of the peritoneum was made. Later, two large fluctuating swellings appeared in the right lumbar region. When I saw him in consultation in the spring of 1904, these had opened, and were discharging a peculiar bloody pus, which, when examined, showed the macroscopic and microscopic evidence of actinomycosis. The patient was very weak; confined to his room. I advised iodide of potash and the X-ray. The latter was carried out by Dr. J. F. Smith, who informs me that the patient has made distinct improvement under the treatment. The region involved in this case is very extensive, and the prognosis therefore grave.